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ABSTRACT

Perspectives on interdisciplinary research are considered in terms of project planning, the choice of problem-solving approach, the research field, project organization, informal organization, and integration of knowledge. Interdisciplinary studies were investigaged through following a number of research projects by means of field trips, occasional participation in the projects themselves, interviews of researchers, and studies of internal working reports. The most important project has been "The Ecology of the Coniferous Forest Landscape" (at the University of Agricultural Sciences, Ultuna, Uppsala). It is suggested that careful preparation is particularly important where interdisciplinary research is concerned, since a connection between background knowledge, problems, field of inquiry, and methods must be established. One difficulty is that the researchers' preconceived notions of the research field (e.g., the level at which interesting mechanisms affecting tree growth are assumed to exist in the ecosystem) are not always clearly pronounced. It has been recognized in the Conifer Landscape project that organizational changes have to be made in step with cognitive development. The change undergone by the project organization can be described in terms of the following processes: a joint venture of participants from various disciplines: awareness of difficulties involved in transcending subject boundaries; and reorganization into subgroups, according to the research problems in hand. A good pilot model of the research topic is essential for the integration of the work done by the various groups. (SW)

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CONCLUDED PROJECT

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CONDUCTED AT	Department of Theory of Science and Research University of Gothenburg Västra Hamngatan 3 S-411 17 GÖTEBORG SWEDEN Tel 031-11 78 44, 11 82 08
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INTRODUCTION

Many research problems transcend subject boundaries at the universities, and more and more interdisciplinary projects are being mounted. The difficulties of interdisciplinary research are numerous and familiar - the difficulty of understanding one another's scientific language, the discipline-oriented qualification norms of the universities, the "ordinary" difficulties of working in research teams. But these difficulties are not only of a more temporary nature or due to interdisciplinary studies being something new which has yet to find its level. Interdisciplinary research will always be more difficult than research in one discipline. This is in the very nature of the research work. A great deal can of course be done to facilitate the interdisciplinary approach, but on the whole one has

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to realize that this type of research demands more resources than other types. However, the boundaries between university subjects are not hard and fast, and interdisciplinary research gradually generates new subjects which, so to speak, are interdisciplinary per se, e g ethnogeography, medical technology, human ecology.

METASCIENTIFIC BACKGROUND, METHODS ETC

The theory of science is a subject which has grown out of philosophy. It deals, for example, with questions concerning the way in which scientific knowledge is formed and tested. Gradually the subject has acquired a more empirical focus. "Science of science" is gradually evolving on a basis of collaboration between sociologists, psychologists, political scientists, historians of science etc. The theory of science has previously been most concerned, for example, with the criteria of good research, often with the aid of historical case studies. It may therefore be interesting to try instead to follow the actual progress of a number of current research projects. Quite a lot of the methodology has been borrowed from sociology of science, but unlike sociology of science the present inquiry is primarily concerned with the cognitive development. One cannot understand research merely by reading the finished research reports; one also has to follow the research process.

The procedure adopted for our investigation of interdisciplinary studies has been to follow a number of research projects by means of field trips, occasional participation in the projects themselves, interviews of researchers, and studies of internal working reports etc.

The most important project has been *The ecology of the coniferous forest landscape* (at the University of Agricultural Sciences, Ultuna, Uppsala). We have also made a number of less extensive studies of the projects *Handling of solid household waste* (at the Chalmers University of Technology, Gothenburg) and *Välsviken* (a project on ecological building at the Centre for Interdisciplinary Studies, Gothenburg).

SUMMARY OF RESULTS

Planning of interdisciplinary research

Careful preparation is particularly important where interdisciplinary research is concerned. In a developed discipline there already exists a close connection between background knowledge, problems, field of inquiry, methods etc. In interdisciplinary research this connection

has to be established. Perhaps not even the nature of the problems is known, and it is only after pilot studies that one knows which fields of competence are required and, accordingly, which researchers will have to take part.

In the Coniferous Landscape project, several researchers have remarked that it would have taken them a couple of years to develop preliminary theoretical models capable of governing subsequent work. This was opposed, however, by some of the more empirically oriented researchers and by the financing organizations, on the grounds that the project had to "get started", i e produce data. As a result, difficulty was experienced for some years in maintaining a connection between the theoretical models and empirical data.

The choice of problem-solving approach and perspective on the research field

Simplifications of reality, into models, to make it manageable, are essential ingredients of all research. Reality can be simplified in various ways. The essence to be retained will depend on what the models are going to be used for. As a result, the epistemology, e g assumptions concerning cause and effect, also differ from one science to another.

A research field can also be variously perceived within a single subject or a narrow group of subjects. In ecology, emphasis can be placed on different "levels" of reality, e g the different individuals, groups of individuals or an entire landscape with its flora and fauna (the eco-system). In the Coniferous Landscape project, the plant physiology researchers may be said, with some oversimplification, to be mainly interested in the individual level and different organs. Their methods have usually been laboratory-oriented, their measuring methods precise and their theoretical models of trees concerned with the daily cycle. Instead, essential parts of the inquiries have to be conducted in the field, with all the difficulties which this implies. Much the same applied to microbiology. Other researchers, e g those in botanical ecology, zoology and meteorology, have been more concerned with the entire eco-system and have studied longer periods - annual cycles or more. Certain fields, such as studies of soil and roots, are highly complex. Measurements are difficult to carry out, and the root system is continually changing. Obviously it is difficult to reconcile these aspects in a "systemic" description of events in the coniferous landscape. In "ordinary" disciplines, problems are considerably delimited and simplified. It is worth pointing out, therefore, that interdisciplinary research is bound to be more complex and to demand more time and resources than research entirely within a single discipline.

Another difficulty is that the researchers' preconceived notions of the research field (e g the level at which interesting "mechanisms" affecting tree growth are assumed to exist in the eco-system) are not always clearly pronounced and discussed by the researchers but are tacitly understood in various working procedures or else vary from one scientific tradition to another. In the Coniferous Landscape project efforts were made to "take a shortcut" by teaching common methods, computer simulation and system theory (in this particular instance, control and regulation of energy and matter in trees and the eco-system) in orientation courses. But insufficient attention was paid to the fact that, behind the methods, there existed a way of thinking and a new way of interpreting the interaction within the eco-system. The researchers disagreed concerning the most fruitful perspective. This was one reason why the original plans for general models of the entire eco-system was abandoned and instead, for a long time, attention was paid to less wide-ranging models.

Project organization

A research project organization cannot be created in one fell swoop. It has been realized in the Conifer Landscape project that organizational changes have to be made in step with cognitive development. Simplifying matters somewhat, the change undergone by the project organization can be described in terms of the following process. To begin with the project was a joint venture involving participants from various disciplines. All the difficulties involved in transcending subject boundaries then became apparent. A crisis in the project was followed by a re-organization into sub-groups, according to the research problems in hand. Thus a change was made from groups of botanists, zoologists, microbiologists etc to groups dealing with problem sectors in the survey, e g energy exchange and micro climate, water turnover, the dynamics of the plant mass above ground.

It is very important in this connection that penetrating pilot studies have been made, so that the nature of the problems can be accurately gauged. A good pilot model of the topic of investigation is essential for the integration of the work done by the various groups. Towards the end of the project, its organization has partly reflected the results aimed at, i e groups round various sub-models (e g growth in various chronological perspectives) and overlapping groups for the integration of findings in a number of major sub-sectors, plant production, soil processes, abiotics (inanimate parts).

Informal organization

A great deal of information concerning important problems, impulses and hypotheses, knowledge of methods, apparatus etc is lacking in research reports and textbooks. Much information of this kind is exchanged by researchers on an informal basis instead, through the exchange of project drafts, MSS, talks, visits and conferences. One learns a great deal about research by doing research. A great deal of this interchange of information is due to a certain problem arising in a certain situation, and it is therefore difficult to plan in advance. Parallel to the working groups, therefore, an informal network of contacts developed between researchers; this network is very important, even after the project has been completed. The times at which the researchers visited the research establishment (Jädraås) were also important; practical field work and informal get-togethers after the day's work taught them a great deal about each other's sciences. Interdisciplinary work was found highly stimulating, in spite of the problems it entails, for example, concerning formal qualifications and appointments at the universities.

Thus interdisciplinary work is greatly dependent on the participants having opportunities of meeting each other; interdisciplinary studies based on an extensive division of labour and with the participants confined to their respective institutions do not work well.

Meetings are not enough for the co-ordination of a project. It is hard to get everybody together at once. Discussions of goals often tend to start from scratch on every occasion, or else formal agreement on decisions will be followed by everybody then doing what they can or want to do regardless. This applies to all the projects we have followed.

Integration of knowledge

Cognitive integration cannot be achieved in an interdisciplinary project merely by effecting a division of labour at the planning stage and then, at the end of the project, putting together what the various participants have done. As has already been made clear, previous knowledge has an important bearing on a systematic division of labour. This makes it easier to systematize the results. (In the Coniferous Landscape project, this preconceived notion can be traced back to earlier projects which have partly been prototypes, the American Biom projects and the International Biological Programme.)

Furthermore, integration occurs in the course of work, as a result of the participants pulling together, learning each other's languages and methods, gradually getting to know different points of view, and so on. This is very important, because certain phenomena in the topic studied are a consequence of the interac-

tion of several factors which cannot only be studied separately. Cognitive integration often benefits if the research project is conducted by stages, with an early presentation of provisional interim findings and with successive modifications of the project strategy thereafter as the overall picture gradually emerges.

Looking further ahead, an integration of theoretical knowledge may also take place. In this case one has to know how the boundaries of different sciences and their views of the problem are to be transcended and a new, common approach created. This is one of the prerequisites of the formation of a new discipline.

Jan Bärmark

Göran Wallén

1980-10-15

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